

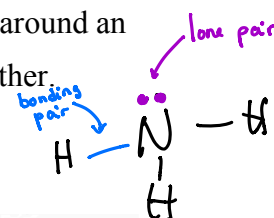
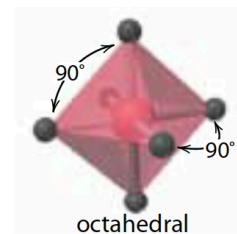
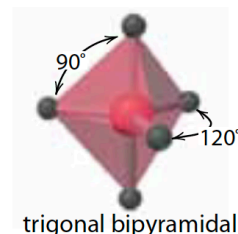
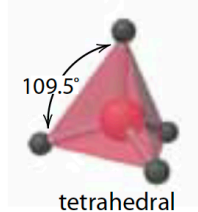
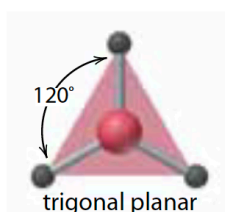
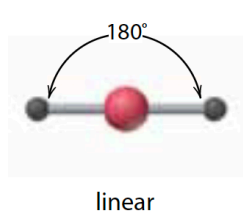
Lesson 7 – VSPER Theory

Shape of Molecules

- Molecules take a 3D shape.
 - This shape affects the physical and chemical properties of a molecule.
- Bond length and bond angle are two factors that affect the shape of a molecule.

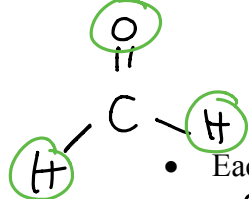
VSEPR Theory

- VSP^EER, or valence-shell electron-pair repulsion, is a model used to predict molecular shapes.
 - VSPER is based on minimizing the repulsion of electron groups around an atom by positioning them as far away as possible from one another.
1. An electron group can be a: single bond, double bond, triple bond, and lone pair.
 2. According to VSEPR theory, there are five basic electron-group arrangements:



*Image taken from McGraw-Hill Ryerson Chemistry 12 (p. 232)

3. It is important to distinguish between
 - Electron-group arrangement: geometric arrangement of the electron groups around a central atom.
 - Molecular shape: geometric arrangement of the surrounding atoms around a central atom.
4. There are three types of repulsive forces that occur in molecules:
 - Between lone pairs (LP-LP)
 - Between bonding pairs (BP-BP)
 - Between lone pair and bonding pair (LP-BP)
5. Lone pairs exert greater repulsive force on neighbouring bonding pairs and lone pairs since they spread out more.
 - According to VSEPR: LP-LP > LP-BP > BP-BP



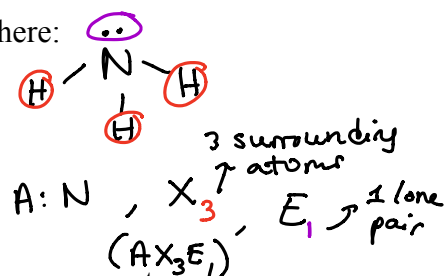
X_3

- Each molecular shape is represented by a formula of the form AX_mE_n , where:

A - central atom

X - surrounding atoms ($m = \#$ of surrounding atoms)

E - lone pairs ($n = \#$ of lone pairs).



- Note that there are more molecular shapes than there are electron-group arrangements
 - Ex: Trigonal planar and bent shape.
 - See the accompanying VSEPR handout.

Guidelines to predict the molecular shape of a molecule:

- Draw the Lewis structure of the molecule (account for the charge of an ion)
- Count the number of electron-groups around the central atom
 - A single, double, and triple bond count as one electron-group (X).
 - A lone pair (or a single valence electron) counts as one electron-group (E).
- Predict the electron-group arrangement based on the total number of electron groups (X and E) around the central atom.
- Predict the shape of the molecule based on the number of bonding pairs (X) and lone pairs (E) around the central atom.

○ Example: PF_3

Step	Strategy
1. Draw Lewis structure Total # of e^- : 26 v.e. #left = 26 - 24 = 2	
2. Count the number of electron-groups around the central atom	$X: 3$ $E: 1$ } Total 4 electron-groups
3. Predict the <i>electron-group arrangement</i> based on the total number of electron groups (X and E together)	4 e^- -groups: tetrahedral
4. Predict the <i>shape</i> of the molecule based on the number of bonding pairs and lone pairs around the central atom (X and E separately).	$X: 3$ $E: 1$ } $AX_3E_1 \rightarrow$ trigonal pyramidal